

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): **Kobayashi**

Serial No.: **N/A**

Filed: **Herewith**

Title: **Method of Fabricating a
Semiconductor Device**

Attorney Docket No.: **N230500C1**

Group Art Unit (of Parent Application): **1763**

Examiner: **N/A**

PRELIMINARY AMENDMENT

5 Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

Dear Sir:

Entry of the following amendments is respectfully requested.

37 C.F.R. §1.10

I hereby certify that this is being deposited with the U.S. Postal Service "Express Mail Post Office to Addressee" service under 37 CFR § 1.10 on the date indicated below and is addressed to:

Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

By: *Bradley T. Sako*

Typed/Printed Name: BRADLEY T. SAKO

Express Mail Label No.: EV183184639US

Date of Deposit: JANUARY 29, 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Specification

Page 1, after the title, please insert the following paragraph.

This application is a **continuation** of patent application Serial No. **09/640,959** filed
5 **August 16, 2000**.

Please replace the paragraph beginning at Page 1, Line 20 with the following replacement paragraph.

10 Two common conductive materials that may be included in a semiconductor
manufacturing process are aluminum and copper. Such materials have been included in
interconnect patterns and the like. However, it has been difficult to form small and/or high
aspect ratio contacts with aluminum. Similarly, while copper can provide advantageously
low resistance, it is believed that many technical problems may have to be overcome before
15 copper contact structures may be practically implemented. In view of the above drawbacks to
materials such as aluminum and copper, many conventional contact forming methods include
tungsten as a contact filling material.

Please replace the paragraph beginning at Page 16, Line 17 with the following
20 replacement paragraph.

Referring now to FIG. 1D, a tungsten film **005** may be deposited over a layered film
of titanium/titanium nitride (**003/004**). A tungsten deposition step may include a mixed gas
that includes a tungsten source gas, such as tungsten hexafluoride (WF_6). In one particular
25 arrangement, a tungsten film **005** may be deposited with chemical vapor deposition
techniques at a temperature of about 400 °C and a pressure of about 6 Torr. Such a tungsten
(W) chemical vapor deposition (CVD) step may form a layer of tungsten **005** over a layered
film of titanium/titanium nitride (**003/004**), thereby filling a contact hole **020**.

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In the Claims

Please cancel claims 1-20.

Please add the following new claims.

5 **21. (New)** A method of forming a contact plug, comprising the steps of:

 selectively making a hole in an insulating layer that has a top surface, a side-wall surface being thereby formed in said insulating layer to define said hole;

 forming a barrier layer on said insulating layer such that a first portion of said barrier layer on said top surface of said insulating layer is greater in thickness than a second portion of said barrier on said side-wall surface of said insulating layer, said second portion of said barrier layer defining a space corresponding to said hole;

 depositing a conductive layer over said first and second portions of said barrier layer while filling said space;

 etching back said conductive layer until said first portion of said barrier layer is exposed to thereby form a plug portion that fills said space and has a top surface which projects above said top surface of said insulating layer; and

 removing said first portion of said barrier layer until said top surface of said insulating layer is exposed to thereby form a contact plug that fills said space and has a top surface which projects above said top surface of said insulating layer.

25 **22. (New)** The method as claimed in claim 21, wherein said barrier layer comprises a first metal film and said first metal film is formed by anisotropic sputtering.

23. (New) The method as claimed in claim 22, wherein said first metal film comprises titanium.

24. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed in an ion metal plasma sputtering manner.

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25. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed in a collimate sputtering manner.

5 26. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed in a long throw sputtering manner.

27. (New) The method as claimed in claim 22, wherein said barrier layer further comprises a second metal film that is formed on said first metal film by an isotropic sputtering.

10 28. (New) The method as claimed in claim 27, wherein said first metal film comprises titanium and said second metal layer comprises titanium nitride.

15 29. (New) The method as claimed in claim 27, wherein said anisotropic sputtering is performed in an ion metal plasma sputtering manner.

30. (New) The method as claimed in claim 27, wherein said anisotropic sputtering is performed in a collimate sputtering manner.

20 31. (New) The method as claimed in claim 27, wherein said anisotropic sputtering is performed in a long throw sputtering manner.

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32. (New) A method of forming a contact hole, comprising the steps of:

etching through a first insulating film to form a contact hole therein;

depositing a first conductive film on the first insulating layer and a side
inner surface of the contact hole;

depositing a second conductive film on the first conductive film;

depositing a third conductive film that fills the contact hole; and

etching to expose the first insulating film around the contact hole and form
a plug from the third conductive film that extends above a top surface of the first
insulating film.

33. (New) The method of claim 32, wherein

the first conductive film comprises titanium; and

the second conductive film comprises titanium nitride.

34. (New) The method of claim 32, wherein

the third conductive film comprises tungsten.

35. (New) The method of claim 32, wherein

the step of etching includes

etching the third conductive film to a level below the first
conductive film and above the first insulating film, and

etching the first and second conductive films to expose the top
surface of the first insulating film.

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36. (New) A method, comprising the steps of:

depositing first conductive film over a first insulating layer having a hole formed therein, the first conductive film being thicker over a top surface of the first insulating layer than on a side surface of the hole;

depositing a second conductive film over the first conductive film;

depositing a third conductive film over the second conductive film and within the hole; and

etching the third conductive film selective to the second conductive film to expose the second conductive film around the hole, the third conductive film being only within the hole and having a plug top that extends above the top surface of the first insulating layer but below a top surface of the second conductive film.

37. (New) The method of claim 36, further including:

selectively etching the first and second conductive films relative to the third conductive film to form expose the top surface of the first insulating film around the hole, the first and second conductive films being only within the hole.

38. (New) The method of claim 36, wherein

the hole is less than 0.3 microns wide.

39. (New) The method of claim 38, wherein

the hole is less than 0.25 microns wide.

40. (New) The method of claim 36, wherein

the step depositing the first conductive film is with an anisotropic method selected from the group consisting of ion metal plasma sputtering, collimate sputtering, and long throw sputtering.

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REMARKS

The Specification has been amended to address typographical errors.

All pending claims from the parent application have been cancelled.

Claims 21-40 are newly added claims.

5

Respectfully Submitted,

 1/29/2002

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Version With Markings to Show Changes Made

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15 provide advantageously low resistance, it is believed that many technical problems may have to be overcome before copper contact structures may be practically implemented. In view of the above drawbacks to materials such as aluminum and copper, many conventional contact forming methods include tungsten as a contact filling material.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Claims.

21. (New) A method of forming a contact plug, comprising the steps of:

5 selectively making a hole in an insulating layer that has a top surface, a side-wall surface being thereby formed in said insulating layer to define said hole;

forming a barrier layer on said insulating layer such that a first portion of said barrier layer on said top surface of said insulating layer is greater in thickness than a second portion of said barrier on said side-wall surface of said insulating layer, said second portion of said barrier layer defining a space corresponding to said hole;

10 depositing a conductive layer over said first and second portions of said barrier layer while filling said space;

15 etching back said conductive layer until said first portion of said barrier layer is exposed to thereby form a plug portion that fills said space and has a top surface which projects above said top surface of said insulating layer; and

removing said first portion of said barrier layer until said top surface of said insulating layer is exposed to thereby form a contact plug that fills said space and has a top surface which projects above said top surface of said insulating layer.

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depositing a third conductive film that fills the contact hole; and

etching to expose the first insulating film around the contact hole and form a plug from the third conductive film that extends above a top surface of the first insulating film.

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